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CONTENTS

MEETING OF AMERICAN PHYSICAL SOCIETY

The One hundred and ninety-eighth regular meeting of the American Physical Society was held in Washington, at the Bureau on April 25 and 26, and at the National Academy of Sciences on April 27. One hundred and thirty-four papers were presented, two of which were by members of the Bureau's staff as follows:

The Establishment and Destruction of Superconductivity at Radio Frequency, by R. B. Scott, F. B. Silsbee, and F. G. Brickwedde.

A New Phenomenon on the Superconducting Transition of Tin and Tantalum, by F. B. Silsbee, F. G. Brickwedde, and R. B. Scott.

The first of these papers described an experiment in which a tin wire 0.022 cm in diameter was supplied simultaneously with direct current and with alternating current of 200 kc/s and of such value that the circular magnetic field in the outer layers exceeded the critical value at one crest of each cycle but was less than critical at the other crest. If the resistance of the material followed these pulsations would it be expected that the flow of the alternating current would produce between the ends of the specimen a drop of potential of distorted wave form containing a strong component of double frequency? Such a double-frequency component of the expected value was found. It varied with the temperature and the magnitudes of the components of current in the manner to be expected. It may be concluded that the mechanism of superconduction can come into action or be destroyed within a few micro-seconds by a sufficiently large magnetic field.

An investigation of the effect of combinations of the variables, temperature, transverse magnetic field, and specimen current, on the resistance in the transition range was described in the second paper. The most characteristic effect, noted when the current was large (several thousand amp/cm^2), was that the passage from the superconducting to the normal resisting condition was accompanied by a spontaneous increase in resistance, occupying several sec-

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onds, followed by a slower return. This transient resistance was sometimes 75 percent of the normal. After such an effect had occurred, it did not occur again when the same conditions were reestablished after a short interval. The combination of variables at which this effect occurred was, however, definite if the time interval was long enough or if the specimen had been cooled to a low temperature. The effect occurred in two tantalum specimens at approximately the same (apparent) current density. The tin wire required about 50 percent greater current density. For tin $H=\frac{2I}{r}$ connects, approximately, with specimen radius the currents and fields which acting alone (1) restore a given fraction of the normal resistance and (2) initiate the spontaneous rise. For tantalum the currents required were only 3 to 4 percent of the calculated values.

TWENTY-FIFTH NATIONAL CONFERENCE ON WEIGHTS AND MEASURES

The Bureau takes pleasure in announcing that a meeting of the National Conference on Weights and Measures will be held on June 4 to 7, inclusive.

At the time of going to press it is not possible to publish a program of the Conference sessions. However, it is probable that specifications and tolerances for the following classes of liquid-measuring apparatus will be considered: Vehicle tanks; large-capacity petroleum meters (wholesale type); vehicle-tank meter installations; and computing liquid-measuring devices of the retail type.

Letters have been mailed to interested individuals and firms requesting suggestions concerning the subjects listed above or relative to specifications and tolerances for other classes of equipment upon which it is believed the Conference might well take action. Such comments should be sent to F. S. Holbrook, Secretary of the National Conference on Weights and Measures, before May 31.

For the benefit of those who have not attended one of these meetings it may be stated that the National Conference on Weights and Measures is an organization composed primarily of State and local weights and measures officials which meets periodically at the National Bureau of Standards in Washington, to consider questions relative to weights and measures administration. One of its important functions is the development of codes and specifications and tolerances for commercial weighing and measuring devices. After such codes have been adopted, first tentatively and later in final form, they are recommended by the Bureau for promulgation and use by States and local jurisdictions. Papers on practical weights and measures subjects are presented and discussed at the meetings by State and local officials, by members of the Bureau's staff and well-qualified members of other Government agencies, and by representatives of outside organizations.

Representatives of manufacturers of weighing and measuring devices also attend the sessions. They are privileged to discuss questions involving their products, but who do not vote upon the adoption of codes of specifications, resolutions, etc. Informative exhibits of newly developed commercial equipment and the demonstration and explanation of such equipment have become valuable features of the meetings.

No meeting of the National Conference has been held since the twenty-fourth meeting in 1931, because of the adverse economic conditions. As a result, the number of important matters scheduled for consideration this year is larger than usual.

Sessions of the Conference will be held on all 4 days; morning and afternoon sessions will be held in the East Building of the Bureau on June 4, 5, and 6, and a morning session and an afternoon session will be held at the hotel headquarters on June 7.

The executive committee of the Conference has selected the Washington Hotel, Fifteenth and F Streets NW., as the hotel headquarters.

"FLOWABILITY" OF MOLDING SANDS

The ability of a foundry sand to move under pressure applied by ramming, and to adjust itself so as to fill uniformly and completely all parts of a mold is a matter of considerable importance in the foundry. In lieu of a better name, the term "flowability" has been used to connote this behavior. Sands differ considerably in this respect. In cooperation with the committee on molding sand research of the American Foundrymen's Association, a study has been initiated at the Bureau to ascertain the relative merits of several methods proposed for measuring the flowability of molding sands. The Bureau has been supplied by a manufacturer of molding-sand testing equip-

ment with an Ames dial type of instrument which can be attached to a standard rammer as a means of studying the relative behavior of molding sands. Comparison will also be made with the deformation values determined by the spring compression test machine developed at the Bureau several years ago for foundry sands.

METALS TO RESIST SMOKE

Keen interest has recently been expressed by railway equipment engineers and by architects in the behavior of metals in atmospheres contaminated with smoke from locomotives. Both severe corrosion and abrasion may be involved. Overhead electrification equipment on railways using both electric and steam locomotives is subjected not only to the corrosive effect of dense smoke but also to the abrasive action of soot and cinders and to the still more severe abrasion arising when electrical contact shoes slide along metal parts which may be coated with soot films. Smoke ducts are usually necessary where steam locomotives pass directly under buildings, the bare metal in such ducts being exposed to severe corrosion. This is also true of steel bridge members over railroad tracks. As several problems of this nature have been brought to the attention of the Bureau's metallurgists in recent months, a review is being conducted of present available information on the subject. Smoke-exposure tests have not, however, been undertaken.

CORROSION SURVEYS

One of the most effective means for reducing the loss occasioned by soil corrosion of pipe lines is by the proper selection and application of protective coatings at the time the line is constructed. The general use of effective coatings will, of course, reduce corrosion, but in general the maximum saving will not be effected because protection is not necessary in all soils. Methods for repairing or reconditioning the corroded parts of the line have been greatly improved and some engineers believe the most economical way to combat corrosion is to lay the line bare and later to recondition and coat the badly corroded parts of the line. The use of a corrosion survey for locating the corrosive soils at the time the line is laid has been tried in some cases, but has not been generally accepted because of the feeling that the methods of estimating the corrosiveness of the soil are not sufficiently reliable.

The American Gas Association and the Bureau have cooperated in the development of a method which is a combination of three widely different methods that have been suggested by others, and the survey is carried out in such a way that the cost is very small. The methods consist in mapping the soil types and in determining the average acidity and average electrical resistivity of each type. A further advantage of the method is that the corrosiveness of the soil is expressed in terms of costs, so that coatings can be selected and applied in such a way that the total average annual cost of combatting corrosion is reduced to the lowest possible amount. The methods have been tested on one old and rather extensive pipe-line system and have been shown to be economical in this case.

SERVICEABILITY OF PLATINUM LABORATORY WARE

The following is an abstract of a paper on the serviceability of platinum laboratory ware of various compositions, presented by Dr. Edward Wichers, chief of the Bureau's section on reagents and the platinum metals, at the meeting of the division of physical and inorganic chemistry of the American Chemical Society in New York on April 25.

At the present time two types of platinum alloys are being used for laboratory ware in the United States. One type, known as standard crucible platinum, contains 0.2 to 0.4 percent of iridium. The other contains 3 to 4 percent of rhodium. Since the introduction of the latter type, only a few years ago, the Bureau has made observations on its performance in service as compared with the older "crucible" platinum. So far no striking differences in quality have been observed. They are about equally constant in weight during prolonged ignition. The platinum-rhodium alloy has a distinct advantage in its greater ruggedness. On the other hand, its tendency to stain or discolor under some conditions of use meets with some disfavor. As yet there is no evidence as to the probable relative life of the two alloys.

The standard "crucible" alloy was adopted by manufacturers some 20 years ago after an investigation at the Bureau had disclosed that the amount of iridium then used in ware (up to 4 percent) caused excessive losses in weight when the ware was heated at temperatures above 1,000° C. More recent observations have indicated,

however, that the iridium content need not be restricted quite so severely. Crucibles containing 0.75 percent of iridium are much more rugged than those containing 0.2 to 0.4 percent (if the weight and design are the same) and do not lose weight rapidly enough, even with free access of air, to cause significant errors in many operations of quantitative analysis. When such crucibles were heated in the flames of Meker-type burners, the loss in weight was almost exactly the same as that of the other two types (about 0.2 mg per 25 ml crucible in 4 hours at 1,100° C). This difference in behavior is due to the virtual exclusion of oxygen from contact with the platinum.

The change in weight of platinum crucibles varies so much with the conditions of heating, as well as with the composition of the ware, that the only safe procedure to follow in work of high accuracy is to determine the changes which actually occur under the conditions of the experimental work. If 1 or 2 empty crucibles of the same type of ware are carried through the entire experimental procedure and used as tares during weighing, the necessary corrections are automatically made.

For dishes and other ware which is not heated to high temperatures for long periods, advantage may well be taken of the hardening effect of larger amounts of iridium. Two percent of iridium is suggested for small dishes (up to 150 ml) and 5 percent for larger ones.

Fabrication of crucibles in such a way that both the bottom and the rim are thicker than the intermediate portion of the wall adds materially to the rigidity and strength of the ware. No evidence has been obtained thus far on the relative merits of different processes of fabrication. Service records show that the simple process of spinning is not objectionable.

If crucibles escape damage by contamination with foreign substances during use, they will eventually go out of service because of the development of intercrystalline cracks. This embrittlement which comes with age is the only remaining serious fault of platinum ware. There is as yet no satisfactory explanation for the development of these cracks. A possible cause is the accumulation of impurities at grain boundaries, either as the result of slow and continuous contamination from gas flames or other outside sources, or of the gradual diffusion of small amounts of impurities which are originally present in the platinum. Sudden failure of a crucible in service is almost sure to be the result of some error or accident in the use of the ware, rather than a fault in its manufacture.

DISCHARGE COEFFICIENTS OF SQUARE-EDGED ORIFICES

During the past 12 years a good deal of experimental work has been done on orifice meters, especially of the types extensively used in the natural-gas industry, in which a square-edged orifice in a thin plate is held between flanges. In the greater part of this work air or gas has been the fluid in the test line. In more than half of these air and gas tests the indications of the "test meter" were compared to the indications of one or more "reference orifice meters." In the remaining tests the indications of the test meter were compared to those of some other device which could be used as an independent reference meter. Such devices were gas holders, flow nozzles, and weighing scales for the condensate when steam was used as the fluid. Coefficients based on some of these latter tests have been used in commercial measurements with orifice meters.

More recently an extensive series of tests was made at Ohio State University, Columbus, Ohio, in which water was used as the fluid and the actual quantity flow determined with tanks and weighing scales. The results of these tests are now being used as the basis on which extensive orifices coefficient tables are being prepared.

It is a matter of much interest and value to know how well the tests with gas agree with those using water. The necessary comparisons have now been made at the Bureau on the basis of the Reynolds' numbers of the fluids. (The Reynolds' number is a product taking into account the dimensions of the orifice, the velocity of the fluid, the density of the fluid, and its absolute viscosity.)

A report of the comparison, prepared by Howard S. Bean, was submitted last March to the gas measurement committee, natural gas department, American Gas Association, which committee has borne the major portion of the expense of tests with which the Bureau has been connected. A report on new coefficients was given by this committee at the meeting of the natural gas department, American Gas Association, in Memphis, Tenn., May 6–9. Except for three orifice plates, which had defective orifice edges, the gas tests agree with the water tests well within the known

experimental uncertainties. In several cases the agreement could hardly be improved upon.

VOLUMETRIC COMPONENTS OF FLUID MIXTURES

In an article by S. H. Ingberg in the May number of Chemical and Metallurgical Engineering, methods of computation are developed applicable to mixtures of fluids in a container or inclosure maintained at constant pressure and volume, assuming perfect and instantaneous diffusion, free efflux, and no reaction within the mixture. For comparison, the equations for mixture within a container from which no efflux takes place are given, and also a treatment applicable to intermediate conditions. Specific applications are developed pertaining to the use of inert gas, such as carbon dioxide, released either from the liquefied form or as one of the inert components of flue gas or engine exhaust gas, to prevent fire and explosion in connection with hazardous processing and storage. Either an inert atmosphere is maintained continuously within the inclosure or a quantity of gas is stored ready for release by manual or automatic means in case fire occurs or a condition develops conducive to fire or explosion. The mathematical treatment applies for the latter condition and to requirements for subsequent ventilation of the spaces thus deluged to reduce the toxic-gas content and raise the oxygen content to limits making such spaces safe for entry.

The development aided by the curve sheets included in the paper enables ready computation of the components of fluid mixtures and comparisons for differences in obtaining conditions. Thus, if one volume of fully inert gas is added to normal air under conditions permitting free efflux, it will constitute 63 percent of the mixture and the oxygen content will be reduced from 21 to 7.8 percent. If no efflux takes place during the admission the inert-gas content will be 50 percent and the oxygen reduced to 10.5 percent. If one volume of inert gas containing 5 percent oxygen is admitted the oxygen concentration will be reduced to 10.8 percent for the condition of free efflux and to 13 percent if no gas is allowed to escape.

In the general case of dilution also the condition of free efflux will accomplish a desired result with the least volume of diluent. While the difference for the two assumptions is not large for additions of less than one-half of the original quantity present, for two volumes of diluent the remaining concentration with free efflux will be about one-half of what would result if the components are contained during the operation. On the assumption of free efflux, 4.6 volumes of diluent are needed to dilute a component from an initial concentration of 2 percent to 0.02 percent, as may be required for a toxic gas such as carbon monoxide before a space can be entered. On the assumption of no efflux 99 volumes of air applied as a diluent would be needed to achieve the same result.

A FILTER FOR OBTAINING LIGHT AT WAVE LENGTH 560 MILLIMICRONS

A filter transmitting a narrow band of light at wave length 560 millimicrons is of particular importance in the colorimetry of sugar solutions, in optical pyrometry, in abridged spectrophotometry, and in photometry. A new 4-component glass filter has been designed in the Bureau's colorimetry section, which isolates and transmits light at 560 millimicrons more effectively than previous filters. Two components of this filter are of Corning glass, two of Jena glass.

The spectral transmissions of the filter and its components are illustrated in RP785 in the May number of the Journal of Research. The spectral centroid of the light transmitted by the filter is at 560 millimicrons for both incandescent and daylight illuminants. The effective wave length for use in optical pyrometry is also close to this value and is nearly independent of temperature and observer. The luminous transmission of the filter is approximately 3½ percent. The luminous efficiency of this transmitted energy is about 99 percent of the maximum possible; the filter thus furnishes a means of securing "cold light."

SPECTRA OF COLUMBIUM

In the decade which has passed since the first indications of structure were found in the first two spectra of columbium, efforts have been made to improve the fundamental data so that the analyses might be extended. Careful estimates of relative intensities and accurate measurements of wave lengths have been compiled for about 3000 Cb I lines and 2000 Cb II lines. In the May number of the Journal of Research (RP793), results are reported for the principal multiplets found in each spectrum. They reveal sextet and quartet terms for Cb I, quintet and triplet terms for Cb II, and account for most of the stronger lines. The normal state of neutral Cb atoms is represented by $(4d^4 5s)\,{}^6\mathrm{D}$, and for singly ionized atoms by $(4d^4)\,{}^5\mathrm{D}$.

GOLD-COBALT RESISTANCE ALLOYS

The unit of electrical resistance is maintained in the national standardizing laboratories by means of wire-wound standards. The national laboratories are interested in improving the quality of these standards, either by improved methods of construction or by the development of better resistance alloys.

Besides stability, resistance alloys should have a low temperature coefficient of resistance and a low thermoelectric power against copper, in order that the standards constructed from them may be readily measured to a high precision. Tests recently made at the Bureau on alloys of gold and cobalt, show that while some of these alloys are reasonably stable in resistance and have very small temperature coefficients of electrical resistance, their thermoelectric power against copper is very large. For this reason they are inferior to gold-chromium alloys of about the same proportions. The results obtained for gold-cobalt alloys are given in RP789 of the Journal of Research for May.

THERMAL EXPANSION OF ANTIMONY

Measurements have been made at the Bureau on the linear thermal expansion of 11 samples of single crystals of antimony and 3 samples of polycrystalline antimony at various temperatures between 20 and 560° C, and the data have been correlated with the results obtained by previous investigators to 300° C. Some of the conclusions, which will be published in the last section of RP784 in the May number of the Journal of Research, are as follows:

Monocrystalline antimony.—The data obtained on the linear thermal expansion of the single crystals of antimony in the first heating and cooling indicate that they were produced in a state of strain. Davey, in 1927, stated that all crystals are produced in a state of strain.

In most cases, the coefficients of linear expansion of the single crystals are higher in the second tests on heating than in the first tests on heating.

Equations have been developed which show the relationships between coefficients of expansion and the orientations of the single crystals of antimony.

The computed values for the average coefficients of expansion of monocrystalline antimony with 0° orientation and 90° orientation, are 17.2×10^{-6} and 8.0×10^{-6}, respectively, between 20 and 100° C.

The coefficient of linear expansion depends upon the direction taken with reference to the trigonal axis. The coefficients of expansion along the trigonal axis (0° orientation) are about twice as large as the coefficients of expansion along a direction perpendicular to this axis (90° orientation). These results confirm Bridgman's statement that the atoms are connected more loosely across the cleavage plane so that external forces produce greater effects perpendicular to this direction (along trigonal axis) than in others.

Polycrystalline antimony. — The linear thermal-expansion curves of polycrystalline antimony show that there is no polymorphic transition between 20 and 560° C.

The average coefficients of linear expansion of 3 samples of polycrystalline antimony are between 8.4×10^{-6} and 11.6×10^{-6} per degree C for various temperature ranges between 20 and 550° C. The cause of the differences obtained in the expansion of different samples of polycrystalline antimony is attributed to variations in the average orientation of the crystals.

THERMAL BEHAVIOR OF THE KAOLIN MINERALS

The minerals of the kaolin group, when heated from room temperature to 1,000° C or higher, exhibit two marked heat effects, (1) an absorption of heat from 450° to 680° C, and (2) an evolution of heat from 925° to 985° C. These effects and the chemical and physical changes which accompany them have been the subject of study for many years, not only because of their intrinsic interest, but because of their importance in relation to heat balance in ceramic kilns, the use of heat-treated clays as additions to portland cement and the production of aluminum from clay.

Evidence obtained at the Bureau in the investigation by X-rays of samples of the kaolin minerals and of synthetic Al_2O_3-SiO_2 gels which have been subjected to controlled heat treatments, shows that the heat absorption is related to the dissociation of clay into water vapor and an intimate mixture of amorphous Al_2O_3 and amorphous SiO_2, and that the heat evolution is caused by the crystallization of γ-Al_2O_3 from amorphous Al_2O_3. The presence of silica is of great importance in retarding the crystallization of γ-Al_2O_3 until a certain "critical temperature" is reached. RP792 in the May number of the Journal of Research should be consulted for the complete account of this work.

SPECIFIC REFRACTIVITY OF SOME GLASSES

Certain data on the composition, index of refraction, and density of some soda-silica glasses, either with or without added lime or alumina, were reported in BS J. Research 6, 1933 (June 1931) RP 320; **9,** 799 (December 1932) RP507; and **14,** 133 (February 1935) RP762.

Considering the applicability of the data to the formulas of Gladstone and Dale, Lorentz and Lorenz, and Eykman and Lichtnecker, the most satisfactory agreement was found to be in the formula of Gladstone and Dale, viz, $(n-1)/d=R$, n being the index of refraction for yellow light, d the intensity, and R the specific refractivity. Assuming the refractivity and density of vitreous (fused) silica as being 1.4587 and 2.2026, respectively (which are consistent with published values and with the Bureau's own data), it can be shown that R for any of the glasses studied can be computed from:

$$100R=(n-1)100/d=0.20835A+0.19335B+0.22435C+0.20750D$$

in which A, B, C, and D are the percentages of silica, soda, lime, and alumina, respectively, in the glass. The constants for A, B, and C are in good agreement with those reported by Morey and Merwin in the J. Optical Soc. Am. **22,** 657 (November 1932).

Similarly, the constants for computing R for glasses containing potash and magnesia, based on unreported data, are 0.20185 and 0.21185, respectively. Computations applying the six constants given above to published data on optical glasses from German and other sources indicate that the constants for the oxides of lead, barium, zinc, and boron should be about 0.130, 0.130, 0.150, and 0.202, respectively.

STANDARD TESTS FOR ENAMELS—REFLECTANCE

It was stated in Technical News Bulletin 213 (January 1935) that the Bureau had agreed, at the request of the Porcelain Enamel Institute, to undertake the development of standard tests for enamels and enameled products, and that the first tests under consideration were to be those for reflectance, abrasion resistance, and acid resistance. In furtherance of this undertaking, a tour of inspection of 15 important laboratories located in the eastern part of the United States was made in March by a representative of the Bureau, in order to compare the methods in use and determine the causes of such discrepancies as exist between the results obtained in the different laboratories. In the case of the reflectance test, which is the first for which a tentative standard will be submitted, the variation in the results obtained at the different laboratories was attributed chiefly to the following causes, in various combinations:

(a) Some instruments were designed to include both specular and diffuse reflection in the reported reflectance values, while others were designed to exclude the specular.

(b) Of the latter type, some were only partially successful in eliminating the specular reflection, especially on a wavy-surfaced enamel.

(c) Some had glass shields in the optical systems, which were so located that upon collecting dust they tended to deflect light into the field of vision not intended to go there.

(d) The reference standards were in some cases not satisfactory, specifically where magnesium carbonate was used for the purpose, since this material varies in reflectance from piece to piece and from time to time.

(e) No uniform practice with respect to light filters was in effect.

(f) Variations in design and calibration of the instruments were conductive to differences in results which can be corrected by the use of a series of standards covering a range of reflecance (instead of a single standard at one reflectance). An example is the nonlinearity of the illumination-current relation in photoelectric cells in the cases of some instruments using these devices.

The variation in results was surprisingly small in view of these sources of error, and plans are under way for supplying the needed reflectance standards, and eliminating other differences sufficiently to bring the results into substantial agreement.

RESISTANCE OF BRICK TO FREEZING AND THAWING

The committee on brick of the American Society for Testing Materials has reported a method of predicting from laboratory tests the freezing and thawing resistance of building brick made from clay or shale. The method of test, which was developed at the Bureau, is as follows: A previously dried brick is weighed and then immersed in water at room temperature for 48 hours and weighed again. The increase in weight represents the water absorbed by the brick. The brick is now immersed in boiling water for 5 hours and the weight again determined. The new weight in-

cludes all of the water absorbed both by cold immersion and boiling. The figure calculated by dividing the percentage increase in weight of the dry brick after 48-hour cold immersion by the percentage increase in weight resulting from both cold immersion and boiling, has been found to be a fairly good measure of resistance to freezing and thawing. This is explained as follows: When water freezes and becomes ice there is a volume expansion of about 9 percent. To allow room for this expansion there must be a residual, unfilled pore space over and above the pore space filled by immersion in cold water. Evidently the relation between cold absorption and absorption after boiling gives some measure of this excess pore space. If the ratio, previously described, is 1.00 the brick is quite sure to fail. The smaller the ratio, the less likely is failure to result from freezing and thawing. To insure resistance to 75 cycles of freezing and thawing the ratio of 48-hour cold-water absorption to 5-hour boiling-water absorption should not exceed 0.80, the flat compressive strength should not be less than 2,500 lb/in.^{2} and the 5-hour boiling-water absorption should not exceed 20 percent.

REFRACTIVE INDEX OF RUBBER

The applicability of refractive-index measurements to the study of rubber has been extended by the development at the Bureau of a method of total reflection, whereby it is possible to determine the index not only for translucent samples but also for samples that are somewhat dark in color and nearly opaque. Determinations of refractive index were made on crude and purified rubber, mixtures of rubber with various compounding ingredients, and vulcanized compounds of rubber and sulphur, covering the range from soft to semihard rubber. Substances mixed with rubber affect the index only insofar as they dissolve in, or enter into combination with, rubber to produce solutions or compounds which differ in index from the rubber. Fillers, including carbon black, titanium dioxide, whiting, and zinc stearate, do not appreciably alter the index of unvulcanized rubber. Sulphur in solution increases n_D^{25} by 0.0016 for each percent, and phenyl-β-naphthylamine, by 0.0015 for each percent. The refractive index of vulcanized compounds of purified rubber and sulphur is given by

$$n_D^t = 1.5190 + 0.00370\ S_c - 0.00035\ (t-25)$$

where S_c represents the percentage of combined sulphur, between 0 and 16, and t, the temperature in degrees centigrade, between 10 and 75° C. Preliminary measurements on compounds containing 19 to 32 percent of sulphur indicate that the transition from soft to hard rubber is accompanied by a decrease in the slope of the curve relating refractive index to temperature.

The complete account of this work will be published as RP786 in the May number of the Journal of Research.

HEATS OF REACTION OF THE SYSTEM: RUBBER-SULPHUR

It has long been known that heat is evolved when rubber and sulphur react in the process of vulcanization. The amount of heat liberated in the production of hard rubber, for example, is sufficient to destroy the rubber if adequate provision is not made for its dissipation. A knowledge of the quantity of heat liberated is of both practical importance and theoretical interest. Several previous investigators have measured this heat effect, but the methods used have been indirect, and the results obtained have not been precise or as consistent as desired. Since measurement of the heat of the reaction in an isothermal calorimeter affords a simple and direct determination, such measurements were made recently at the Bureau. The apparatus consists essentially of a well-insulated metal block which can be heated electrically, or cooled by the addition of steel balls, so as to maintain a constant temperature of about 175° C. For the determination, a weighed sample of unvulcanized rubber-sulphur mixture at room temperature is placed in a cavity of the heated metal block. The block is, of course, cooled by the introduction of the sample, but this effect is compensated for by the addition of a measured quantity of heat energy by electrical means. Soon, however, the reaction of the rubber and sulphur begins to liberate heat and warm the block. The heat of reaction is measured by the number of steel balls, at room temperature and of known heat capacity, which must be dropped into a cavity in the heated block to maintain the equilibrium temperature. The results, which are reported in RP791 in the May Journal of Research, indicated that complete vulcanization proceeds in two stages, the first of which liberates a greater quantity of heat than the second. To facilitate the use of the results equations have been developed which give the heats of the reaction in terms of the proportion of sulphur to rubber in the mixture.

MOLECULAR WEIGHT OF RUBBER HYDROCARBON

Lacquers containing high viscosity cellulose nitrate, if shipped by train from New York, N. Y., to San Francisco, Calif., have an initial viscosity approximately 4 times as great as that of a similar lacquer, which is shipped to Cincinnati, Ohio. The vibration during shipment reduces the viscosity of the lacquer. If a mineral acid is added to a viscous rubber cement, and the cement is exposed to sunlight, it quickly becomes fluid. The structures of the cellulose nitrate and of the rubber are changed, and the change presumably is accompanied by a lowering of the molecular weight. There is described in BS J. Research 10, 479 (April 1933) RP544 a method of purifying rubber hydrocarbon, the chief purpose of which is to maintain the structure of the rubber unchanged during purification. Subsequently the rubber is separated into two fractions by ethyl ether. Approximately 75 percent is soluble and 25 percent is insoluble.

Much work has already been done on the molecular weight of total rubber by many investigators, and the values reported in the literature vary from about 300 to 82,000. Many of them were determined by observing the depression of the freezing point. They do not indicate the molecular weight of rubber in its highest physical aggregation, which is a condition of special interest to chemists who are investigating the synthesis of rubber. Determinations of molecular weight by freezing-point depression are obviously unsuitable if the molecular weight is very high.

Drs. E. O. Kraemer and W. D. Lansing, of E. I. duPont de Nemours & Co., Wilmington, Del., have recently determined the molecular weight of an ether-soluble fraction prepared at the Bureau. They used the Svedberg ultracentrifuge, and the method employs sedimentation equilibrium, which is thermodynamically equivalent to the freezing point method, and, like the latter, is not influenced by the shape of the molecule.

The average molecular weight of the soluble rubber fraction is about 500,000. Prof. George L. Clark, of the University of Illinois, who is investigating the X-ray diffraction patterns of soluble and insoluble rubber prepared at the Bureau, and is also examining crystalline rubber, some time ago deduced from data obtained in part by X-ray measurements that the molecular weight of cellulose is 500,000. Drs. Kraemer and Lansing have recently determined the molecular weight of cellulose by the Svedberg method and report a value of 500,000. Cellulose and the soluble rubber fraction, therefore, have comparable molecular weights, and they are said to have "giant molecules." As a result of the work of Kraemer and Lansing, chemists interested in the synthesis of rubber now have a definite goal, in the shape of a known molecular weight, for which to strive, in order to make synthetic rubber that is comparable to Hevea rubber. Their work was described in detail at the meeting of the American Chemical Society in New York City, April 22 to 26, 1935.

THE AMINO NITROGEN CONTENTS OF WOOL AND COLLAGEN

The basic properties of wool and collagen are largely attributed to the free amino groups in these materials. Various investigators have attempted to quantitatively relate these groups to combination with acids, dyes, and tannins.

The method these investigators employed is based on the reaction between the free amino groups and nitrous acid, whereby nitrogen of the amino group is liberated and the amino group is replaced by a hydroxyl group. The values they obtained for the amino nitrogen contents varied greatly. The results of an investigation recently completed at the Bureau show that their values do not necessarily represent the true amino nitrogen contents and are dependent on the conditions under which their determinations were made. Owing to these discrepancies, their attempts to relate the free amino nitrogen to chemical combination may be considered solely of a qualitative nature.

When wool, collagen, and arginine were treated with nitrous acid, increasing amounts of nitrogen were evolved with time. The continued evolution of nitrogen was due to the action of nitrous acid on the guanidine nuclei of these materials.

A new method for the determination of the arginine content of a protein has been developed, based on the relative rates of evolution of nitrogen from the guanidine nuclei in a protein and in arginine.

The evidence shows that the action of nitrous acid on the guanidine nuclei is different from its action on a free amino group. The free amino nitrogen contents of wool and collagen have been calculated by subtracting from

the total nitrogen evolved that portion of nitrogen which came from the guanidine nuclei. The values obtained for the percentages of the total nitrogen as amino nitrogen are 2.53 for wool and 2.77 for collagen. These results are set forth in greater detail in the May number of the Journal of Research (RP787).

FADING OF DYED TEXTILES

Seven selected dyeings were exposed to the radiation of the glass-enclosed carbon-arc lamp at distances from the arc selected to give intensities at the sample equal to that in the Fade-Ometer and to 0.3, 0.1, and 0.02 of that intensity. The temperature of the air about the dyeings was maintained at 43° C and the relative humidity at either 75 or 31 percent. The change in spectral reflectance with time of exposure was determined.

The time of exposure required to produce a given amount of fading at intensity 0.1 may be anywhere from 10 times to only 2 times that required at intensity 1. Thus, the relative fastness to light of dyeings when exposed at one intensity, for example, that of noon sunlight, is not necessarily their relative fastness when exposed at another intensity, for example, that of the diffused daylight in a room.

The rate of fading of some dyeings is not affected by a change in the relative humidity of the surrounding atmosphere from 75 percent to 31 percent, but the rate of fading of others is retarded by a factor of 2.

FIRE-RESISTANT DOPED FABRIC FOR AIRCRAFT

The rapid growth of the aviation industry in this country has brought to the fore the problem of eliminating the fire hazard inherent in the cellulose-nitrate doped fabric now commonly used to cover the wings and fuselage of service airplanes. The destruction of costly aircraft because of the accidental ignition of the flammable covering by the backfiring of the engine, the careless toss of a lighted match or cigarette, or the chance settling of a spark from a nearby flue has become too general an occurrence. An investigation was, therefore, undertaken by the Bureau, with the financial assistance of the National Advisory Committee for Aeronautics, to develop a nonflammable doped fabric for aircraft. The results of this study were presented by Gordon M. Kline at the meeting of the paint and varnish division of the American Chemical Society in New York, on April 23, and will also be published in the May number of the Journal of Research as RP788.

The use of natural and synthetic resins and mixtures of synthetic resins with cellulose nitrate and cellulose acetate has been investigated. The resins do not tighten the fabric sufficiently to be satisfactory as airplane dopes. In general, a 3:1 ratio of cellulose derivative to resin is necessary to attain satisfactory tautness. In this proportion even the least-combustible resins do not markedly improve the fire resistance of the doped fabric. No method has been found to fireproof airplane fabric doped with cellulose nitrate and maintain satisfactory tautness and weight requirements. An airplane covering with very good resistance to ignition can be obtained by the application of a 3:7 boric-acid-borax mixture to airplane cloth and subsequently doping it with cellulose acetate. This doped and fireproofed cloth, containing approximately 5 percent of the boric-acid-borax mixture, by weight, will not burn in a horizontal or vertical position and is not ignited by lighted matches or burning gasoline.

COMMERCIAL STANDARD FOR BOOKBINDING BOARD

Information on the commercial standard for chip board, laminated chip board, and miscellaneous boards for bookbinding purposes, established by manufacturers and users under the auspices of the Bureau, is contained in pamphlet CS49–34, now obtainable from the Superintendent of Documents, United States Government Printing Office, Washington, D. C., at 5 cents per copy.

The commercial standard records the requirements and methods of test for such elements as bundle weight, classification, grades, color, density, trim, and bursting strength, which are now accepted as the national standard basis for inspection, acceptance tests, and certification of quality of the material.

The pamphlet includes a brief history of the project, the membership of the standing committee which reviews, prior to circulation for acceptance, all revisions proposed to keep the standard abreast of progress, as well as a list of acceptors. The standard became effective for new production on December 15, 1934.

According to representatives of the industrial organizations concerned, the standard will serve as a basis for fair competition and will tend to eliminate much of the misunderstanding and uncertainty of the past in the purchase of

this board. The original draft was prepared by the Employing Bookbinders of America, based on data obtained at the Government Printing Office.

STANDARDS FOR PAPER TOWELS

A revised edition of Circular C294, Standards for Paper Towels, has been issued by the Bureau, to report the results of further research on the subject. The new publication is designated C407, and copies are obtainable from the Superintendent of Documents, United States Government Printing Office, Washington, D. C., at 5 cents each.

An important finding of the additional investigation is that towels may become unserviceable during a normal storage period through decrease in the rate of absorption of water. Towels representative of the domestic products were stored at the Bureau, and periodic tests of them showed that their absorptiveness decreased steadily and to such an extent that at the end of 6 months some of them had unsatisfactory absorptive quality. No constant relation between this behavior and the other properties of the towels was found. A study of the use of a heat test to foretell the extent of loss of absorptiveness revealed that the results of a 1-hour heat treatment at 100° C. may safely be used to predict whether a towel will lose too much of its absorptiveness during storage, and this test is recommended as an improved means of testing absorptive quality in the evaluation of towels. The only other serviceability test required, in the opinion of the Bureau, is the determination of tensile breaking strength, although the towels should be inspected for softness, cleanliness, and imperfections.

The Circular contains a discussion of the components and properties of towels relative to their evaluation, and mentions the technical requirements of the Federal specification used for their purchase, which is based on the results of the investigation.

REVISED COMMERCIAL STANDARD FOR FUEL OILS

Commercial Standard CS12–35 on fuel oils (third edition) is now available in printed form. This constitutes a revision of the second edition, CS12–33, and covers the more important characteristics essential to satisfactory burning oils. Six distinct grades are described with limits as to flash point, pour point, water and sediment, carbon residue, ash, distillation range, and viscosity. Experience has indicated the advantage of limiting the above characteristics in order to provide a better classification for competition and an improved system of designating quality, which before the appearance of definite grade standards was limited only by gravity—an index now looked upon as a very poor indicator of suitability for any given burner.

The commercial standard was originally published in 1929. Oils used for heat-treatment furnaces, for glass and ceramic furnaces, and other special uses, sometimes necessitate a low sulphur requirement. To meet these special needs the standard was revised to carry a table showing permissible maximum sulphur content for each grade as a guide for the purchasers. This revision was published in 1933 under the abbreviated title of Fuel Oils (second edition), Commercial Standard CS12–33.

In order to prevent overlapping of grades and misrepresentation in the direction of supplying a lighter oil than indicated by the grade number, both upper and lower limits for some characteristics have been incorporated in the present revision. Maximum limits for carbon residue or ash content are included in grades 1 to 5. As a result of improvement in oil burners the viscosity of no. 3 oil has been increased, as representing the heaviest grade suitable for use in certain domestic types of burners. Numbers 4, 5, and 6 are suitable generally for industrial types of burners.

Although the latest revision closes the major loopholes for misunderstanding and unfair competition as indicated by composite experience, it is generally conceded that additional data and possibly some new criteria are needed as a basis for future revisions to insure a more complete adaptation of burners and fuel oils to each other.

Having been endorsed by a large number of important oil refiners, burner manufacturers, distributors, and organized consumers, estimated to represent a satisfactory majority, the revised standard became effective February 15, 1935.

The pamphlet includes, in addition to the standard specification, a list of acceptors and a brief history of the project. Copies may be obtained from the Superintendent of Documents, Washington, D. C., at 5 cents each.

NEW AND REVISED PUBLICATIONS ISSUED DURING APRIL 1935

Journal of Research [1]

Journal of Research of the National Bureau of Standards, vol. 14, no. 4, April 1935 (RP775 to 783, inclusive). Price 25 cents. Obtainable by subscription.

Research Papers [1]

[Reprints from the January and February 1935 Journal of Research]

RP753. Factors affecting the performance of hosiery on the hosiery-testing machine. H. F. Schiefer and R. S. Cleveland. Price 5 cents.

RP756. A Maxwell triangle yielding uniform chromaticity scales. D. B. Judd. Price 5 cents.

RP757. Use of the pipette method in the fineness test of molding sand. C. E. Jackson and C. M. Saeger, Jr. Price 5 cents.

RP762. Index of refraction, density, and thermal expansion of some soda-alumina-silica glasses as functions of the composition. C. A. Faick, J. C. Young, D. Hubbard, and A. N. Finn. Price 5 cents.

Circulars [1]

Supplement to C398. Standard samples issued or in preparation by the National Bureau of Standards. (Feb. 18, 1935.) Free on application to the Bureau.

C407. Standards for paper towels. B. W. Scribner and R. W. Carr. Price 5 cents. (Supersedes C294.)

Simplified Practice Recommendations [1]

R103–33. Industrial truck and trailer solid tires. Price 5 cents.

R131–35. Glass containers for mayonnaise and kindred products. Price 5 cents.

Commercial Standards [1]

CS49–34. Chip board, laminated chip board, and miscellaneous boards for bookbinding purposes. Price 5 cents.

Technical News Bulletin [1]

Technical News Bulletin No. 216, April 1935. Price 5 cents. Obtainable by subscription.

[1] Send orders for publications under this heading only to the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research, $2.50 per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and the Republic of Panama); other countries, 70 cents and $3.25, respectively.

LETTER CIRCULARS

It is the intent of the Bureau to distribute single copies of these Letter Circulars on request only to those parties having special interest in the individual Letter Circular. Economy necessitates limitation in the number of copies issued. It is not the intent to supply parties with a copy of each Letter Circular issued during the month. Letter Circulars are necessarily of a temporary nature designed to answer numerous inquiries on a given subject. Requests should be addressed to the National Bureau of Standards.

LC439. Publications on gages (dimensional). (List of publications and articles by members of the staff published in the Bureau's series of publications and in outside journals.)

OUTSIDE PUBLICATIONS [2]

Definitions of power and related quantities. H. L. Curtis and F. B Silsbee. Preprint of paper to be presented at summer convention, Am. Inst. Elec. Eng. (33 West 39th St., New York, N. Y.) at Ithaca, N. Y., June 24–28, 1935.

Ionosphere studies. E. B. Judson. Phys. Rev. (Corning, N. Y.), **47**, 590 (March 15, 1935).

Steam research at the Bureau of Standards. N. S. Osborne, H. F. Stimson, and D. C. Jennings. Mech. Eng. (29 West 39th St., New York, N. Y.), **57**, 162 (March, 1935).

Preparation of pure gallium. J. I. Hoffman. Metal Industry (22 Henrietta St., Strand, London, W. C. 2, England), **46**, 335 and 391 (March 22 and April 5, 1935).

Frontiers of aerodynamics. H. L. Dryden J. Wash. Acad. Sci. (Washington, D. C.), **25**, 101 (March 15, 1935).

The double-modulus theory of column action. W. R. Osgood. Civil Eng. (33 West 39th St., New York, N. Y.), **5**, 173 (March 1935).

Discussion: Rational design of steel columns, by D. H. Young. W. R. Osgood. Proc. Am. Soc. Civil Eng. (33 West 39th St., New York, N. Y.), **61**, 391 (March 1935).

Tests of Mesnager hinges. D. E. Parsons and A. H. Stang. J. Am. Concrete Inst. (7400 Second Boulevard, Detroit, Mich.), **31**, 304 (January–February 1935).

Melting conditions of aluminum. A. I. Krynitsky and C. M. Saeger, Jr. The Foundry (Penton Building, Cleveland, Ohio), **63**, 21 (March 1935).

[2] These publications are not obtainable from the Government unless otherwise stated. Requests should be sent direct to the publishers.

Foundry sands. Specification O. S. 791. (U. S. Naval Gun Factory, Washington, D. C.) (March 1935.)

Crushed silica rock for foundry use. Specification O. S. 792. (U. S. Naval Gun Factory, Washington, D. C.) (March 1935.)

The analysis of feldspar. H. B. Knowles and J. C. Redmond. J. Am. Ceram. Soc. (2525 North High St., Columbus, Ohio), **18**, 206 (March 1935).

Defects produced by stones in glass. Herbert Insley. Glass Ind. (233 Broadway New York N. Y.) **16**, 79 (March 1935).

Index of refraction, density, and thermal expansion of some soda-alumina-silica glasses as functions of the composition. C. A. Faick, J. C. Young, Donald Hubbard, and A. N. Finn. Glass Ind. (233 Broadway, New York, N. Y.), **16**, 81 (March 1935).

Strength and Young's modulus of some ground-coat enamels for sheet iron. W. N. Harrison, S. M. Shelton, and W. H. Wadleigh. J. Am. Ceram. Soc. (2525 North High St., Columbus, Ohio), **18**, 100 (March 1935).

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